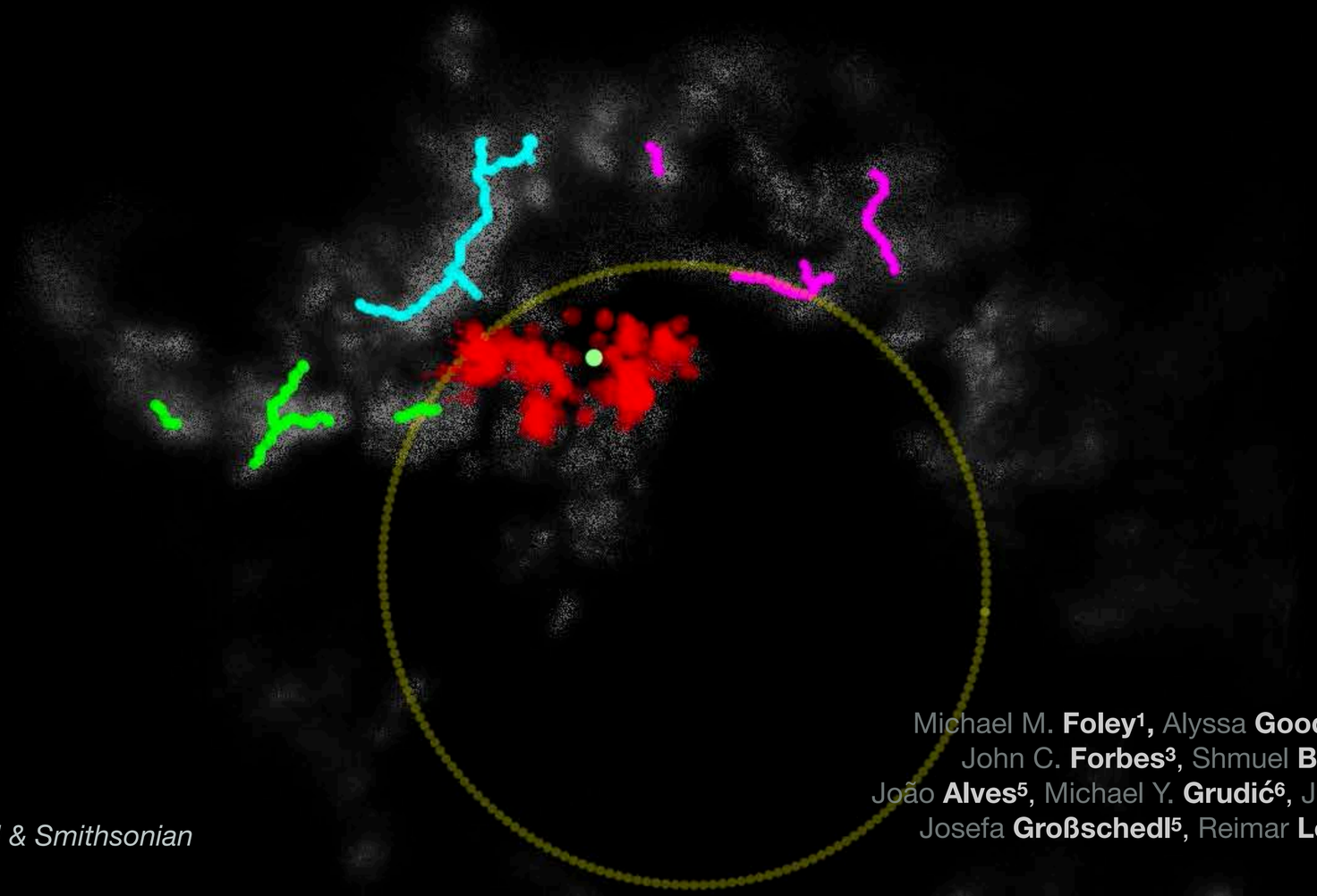
Building a 3D View of the Orion Star-Forming Region



presented by Michael **Foley**
NSF Graduate Research Fellow
Center for Astrophysics | Harvard & Smithsonian

Paper by
Michael M. **Foley**[1], Alyssa **Goodman**[1], Catherine **Zucker**[2], John C. **Forbes**[3], Shmuel **Bialy**[4], Cameron **Swiggum**[5], João **Alves**[5], Michael Y. **Grudić**[6], John **Bally**[7], Juan D. **Soler**[8], Josefa **Großschedl**[5], Reimar **Leike**[9,10], Torsten **Ensslin**[9,10]

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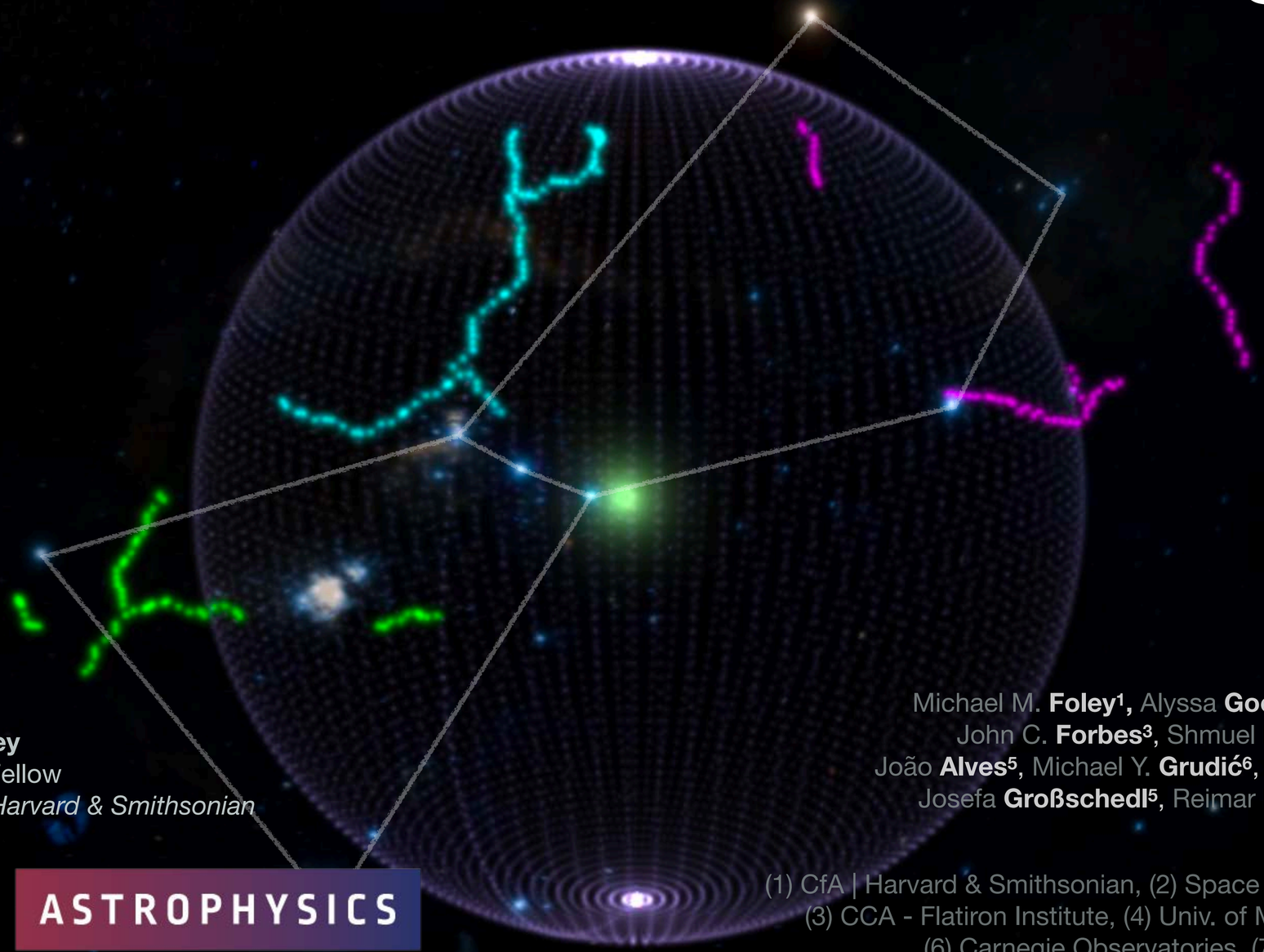

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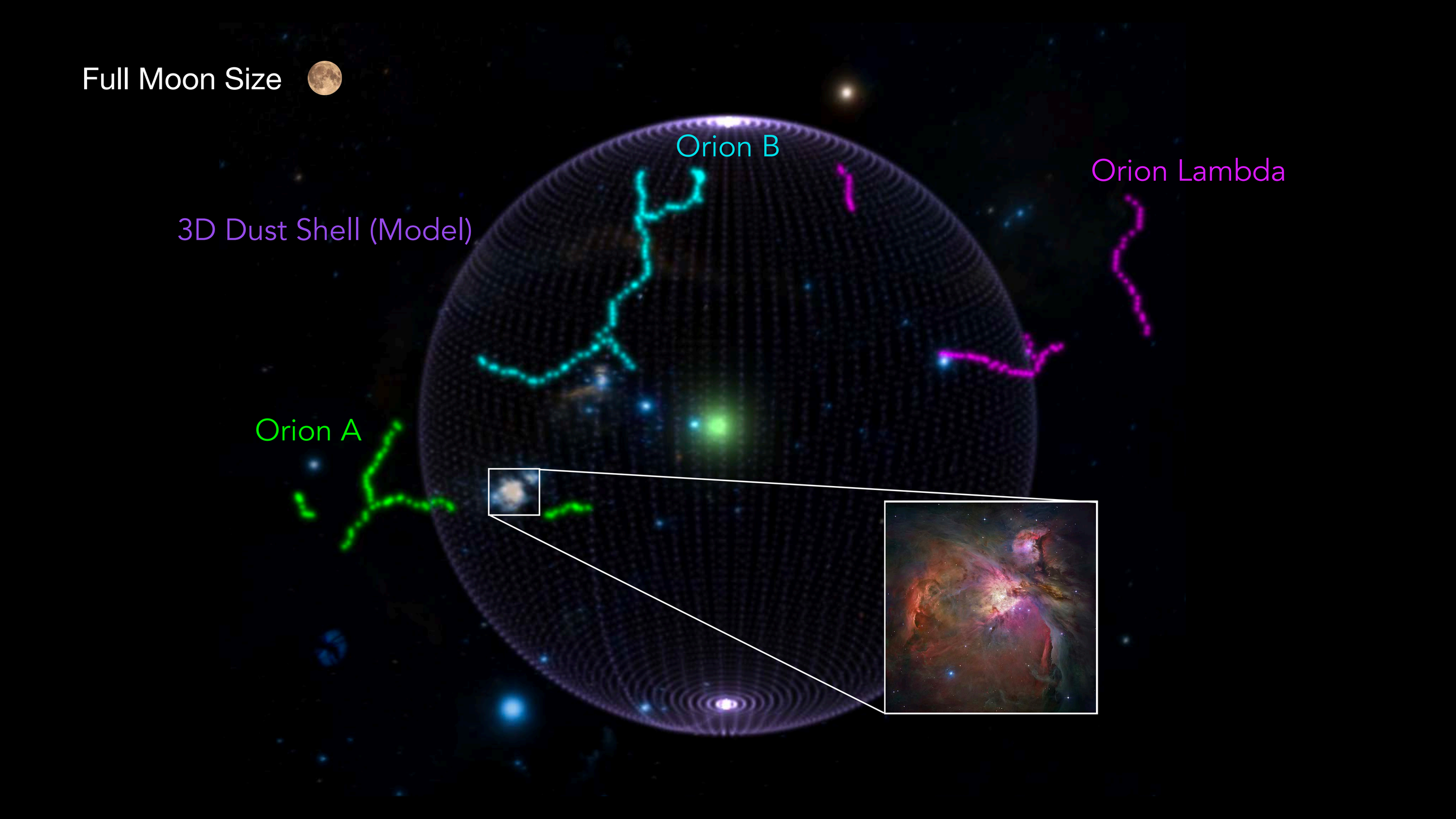
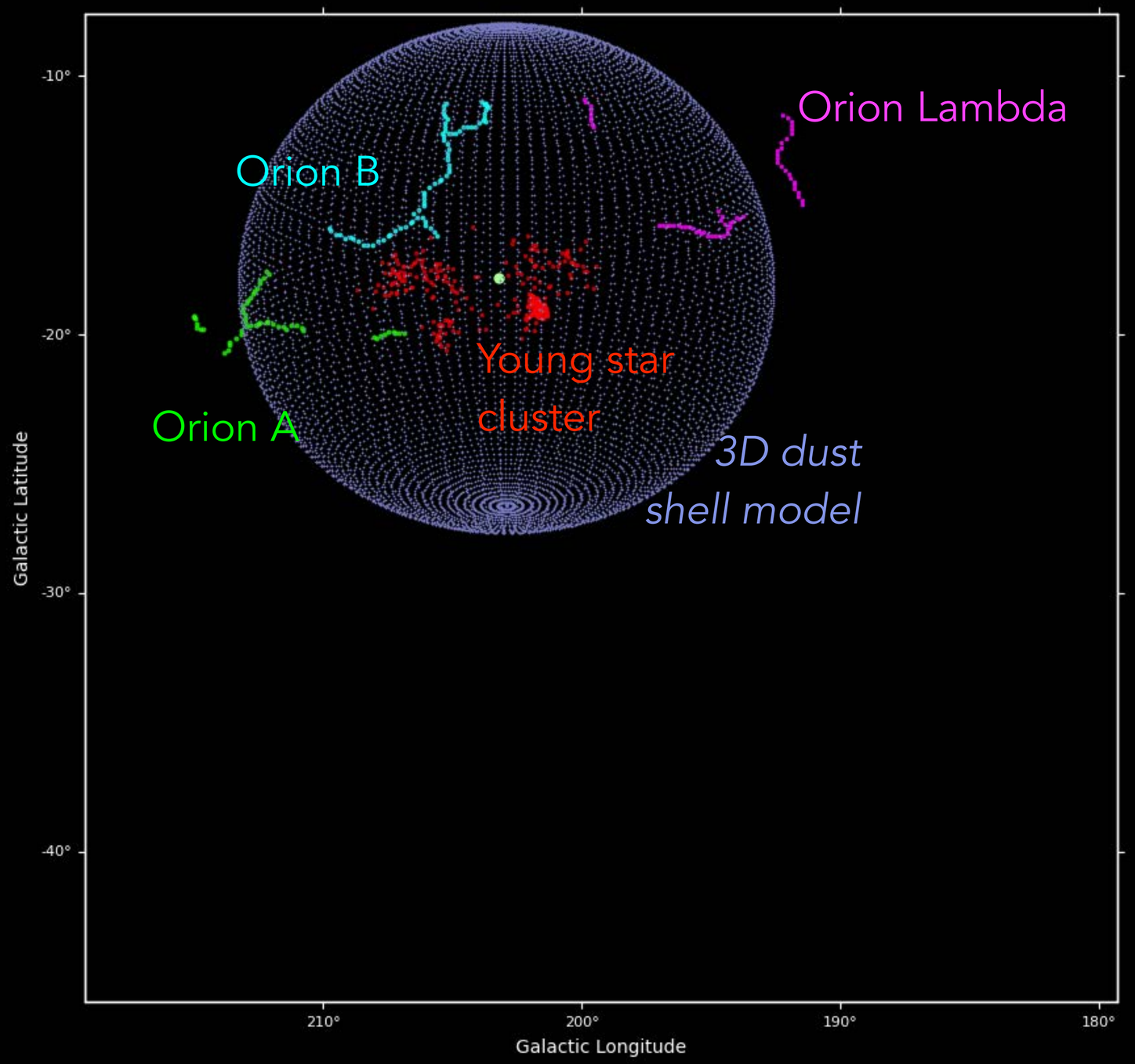
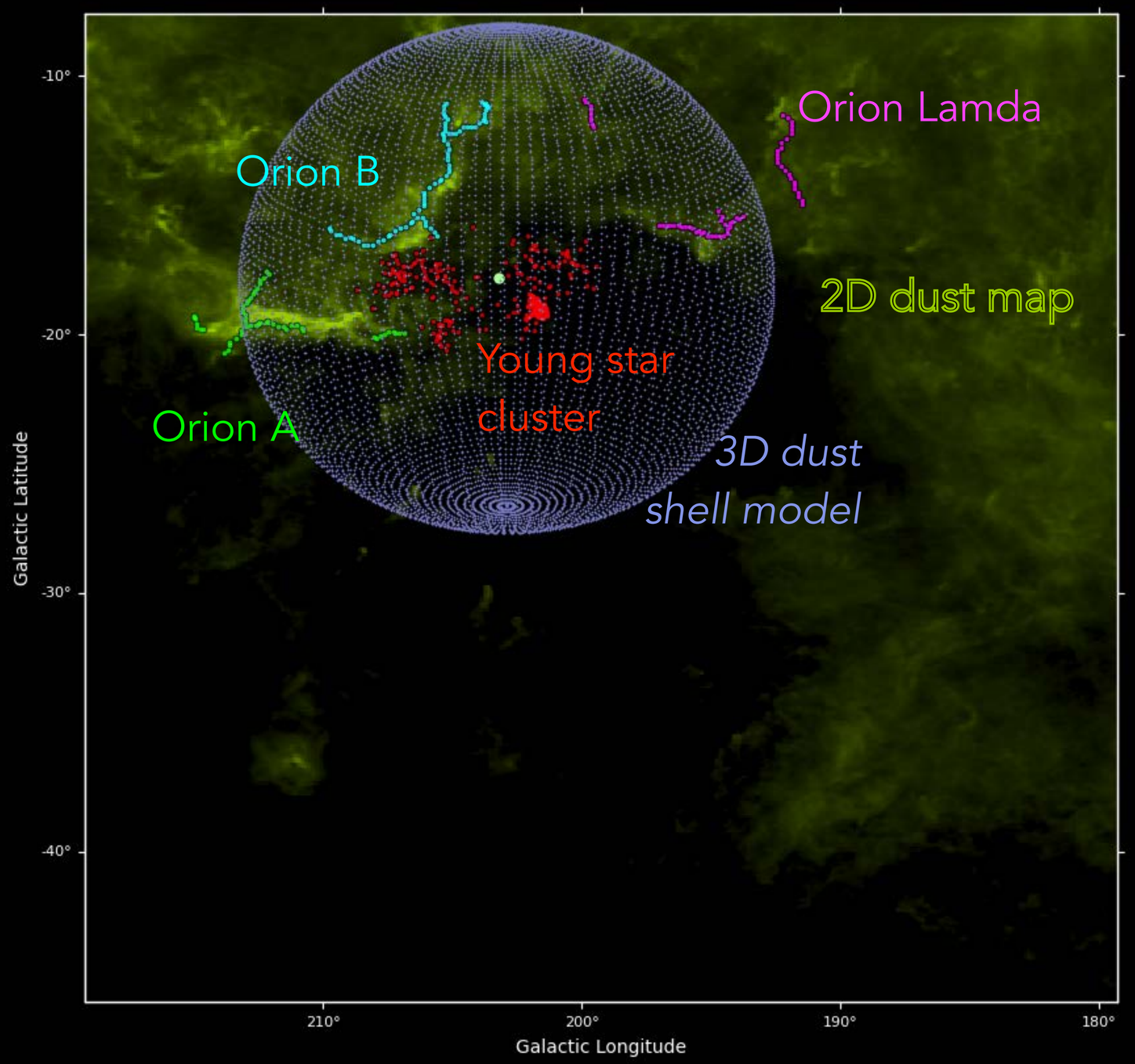

Full Moon Size
Orion B
Orion Lambda
3D Dust Shell (Model)
Orion A

2D to 3D


Orion Lambda
Orion B
Young star
cluster
Orion A
3D dust
shell model
-10°
-20°
-30°
-40°
Galactic Latitude
210°
200°
190°
180°
Galactic Longitude

2D to 3D


Orion Lamda
Orion B
2D dust map
Young star
cluster
Orion A
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-10°
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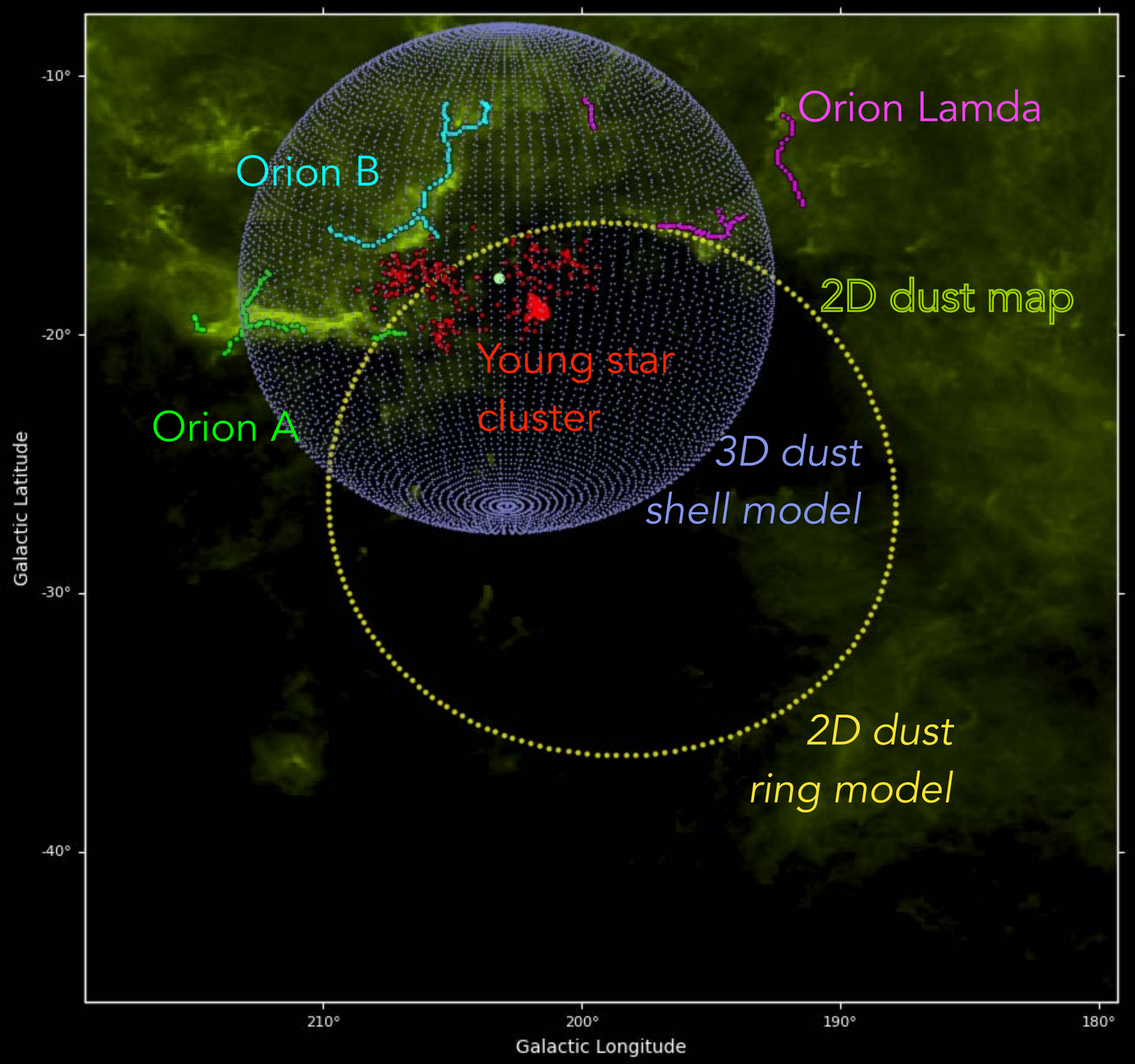
2D to 3D


Orion Lamda
Orion B
2D dust map
Young star
cluster
Orion A
3D dust
shell model
2D dust
ring model
-10°
-20°
-30°
-40°
Galactic Latitude
210°
200°
190°
180°
Galactic Longitude

2D to 3D

Orion B

Orion A

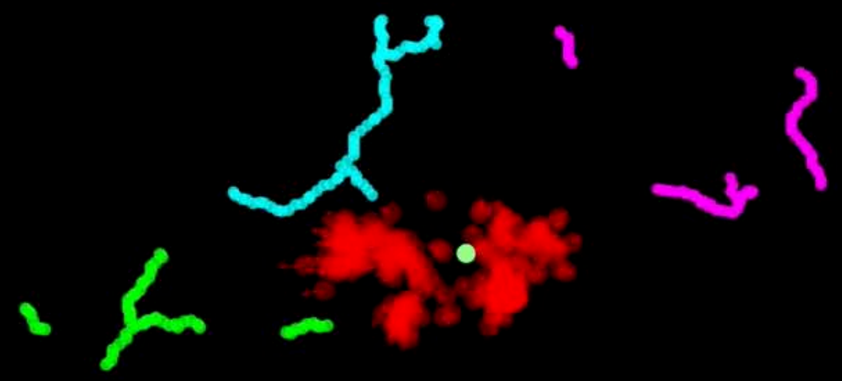
Orion Lamda

Young star cluster

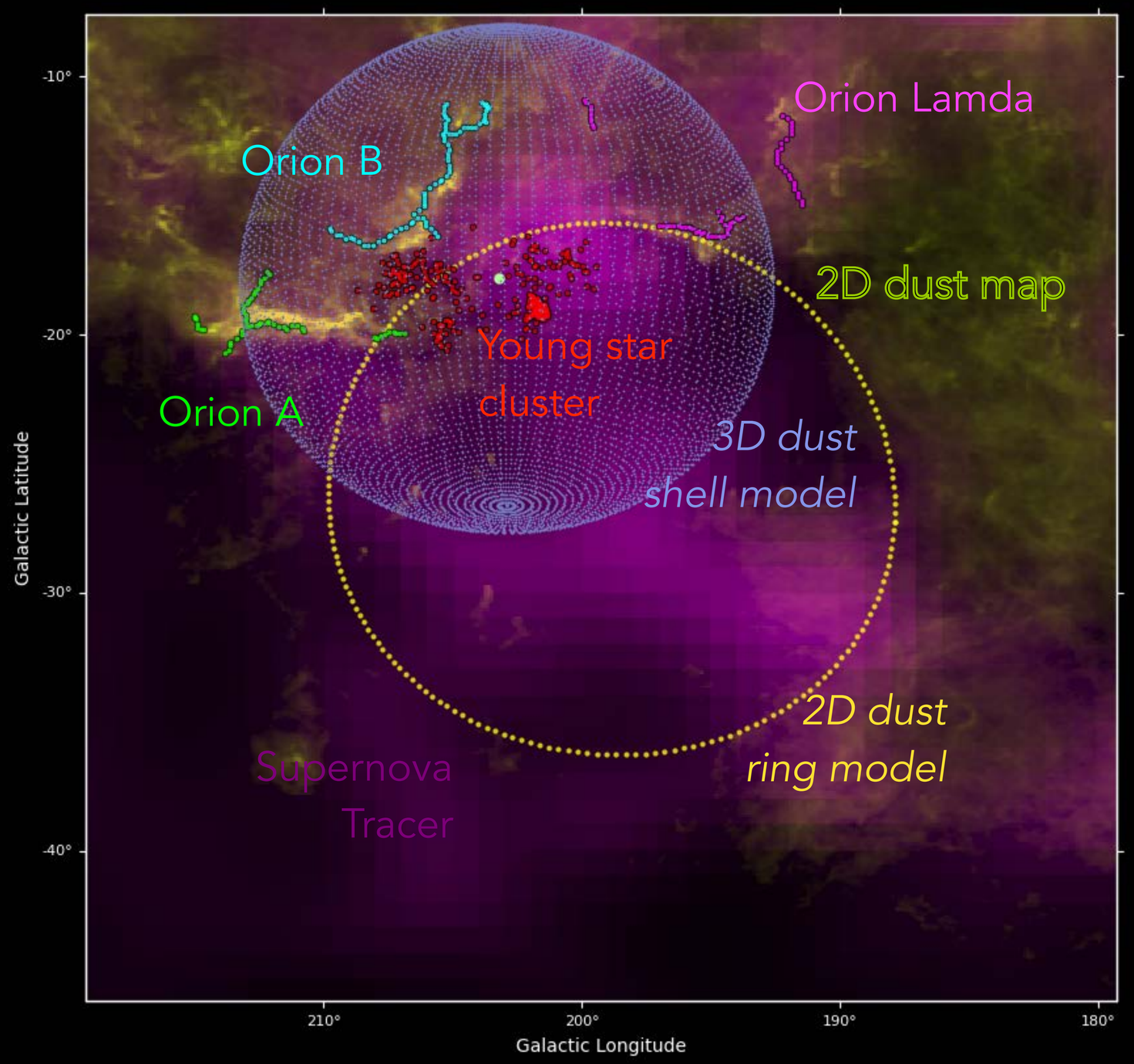
3D dust shell model

2D dust ring model

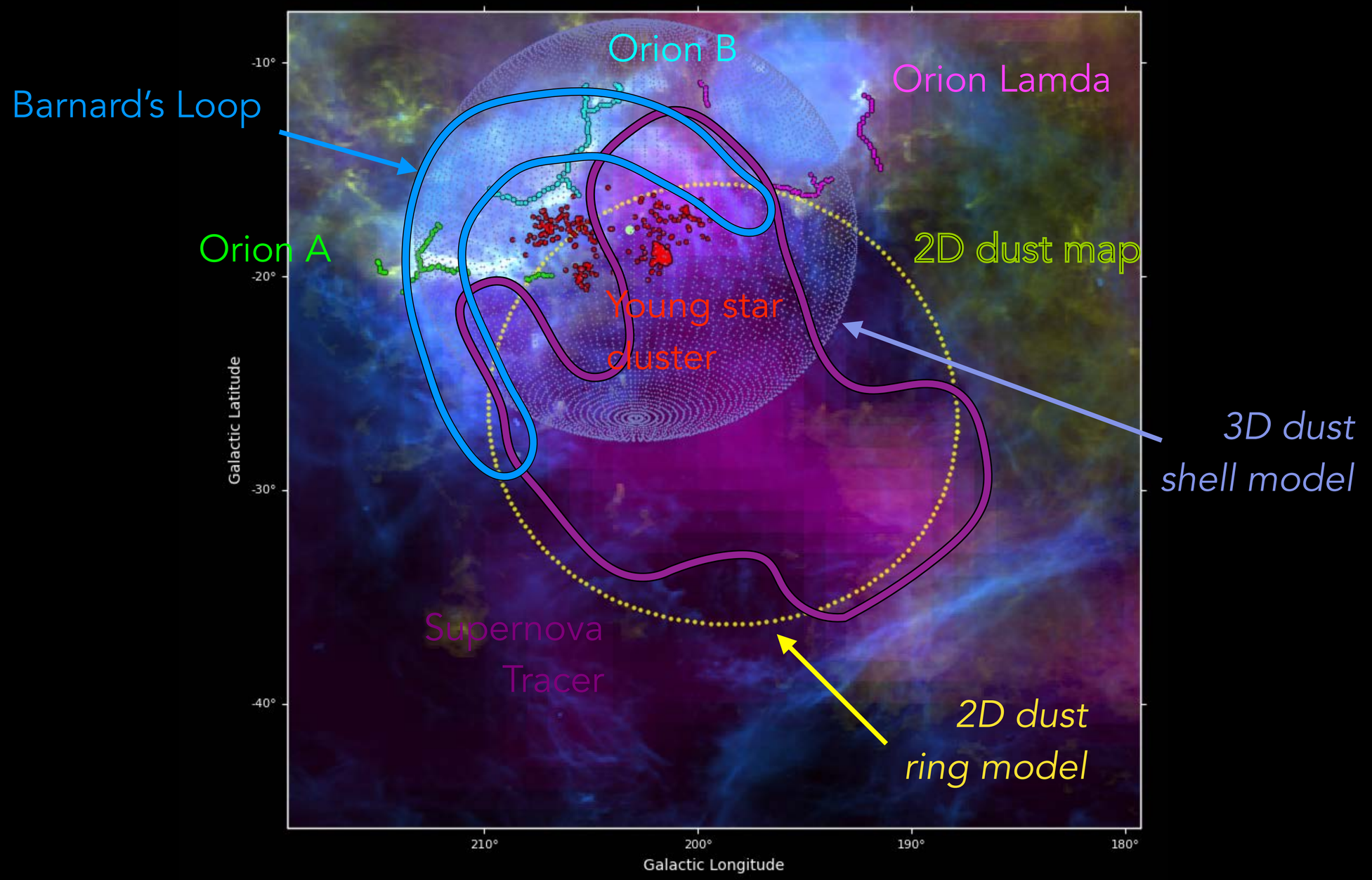
expansion center

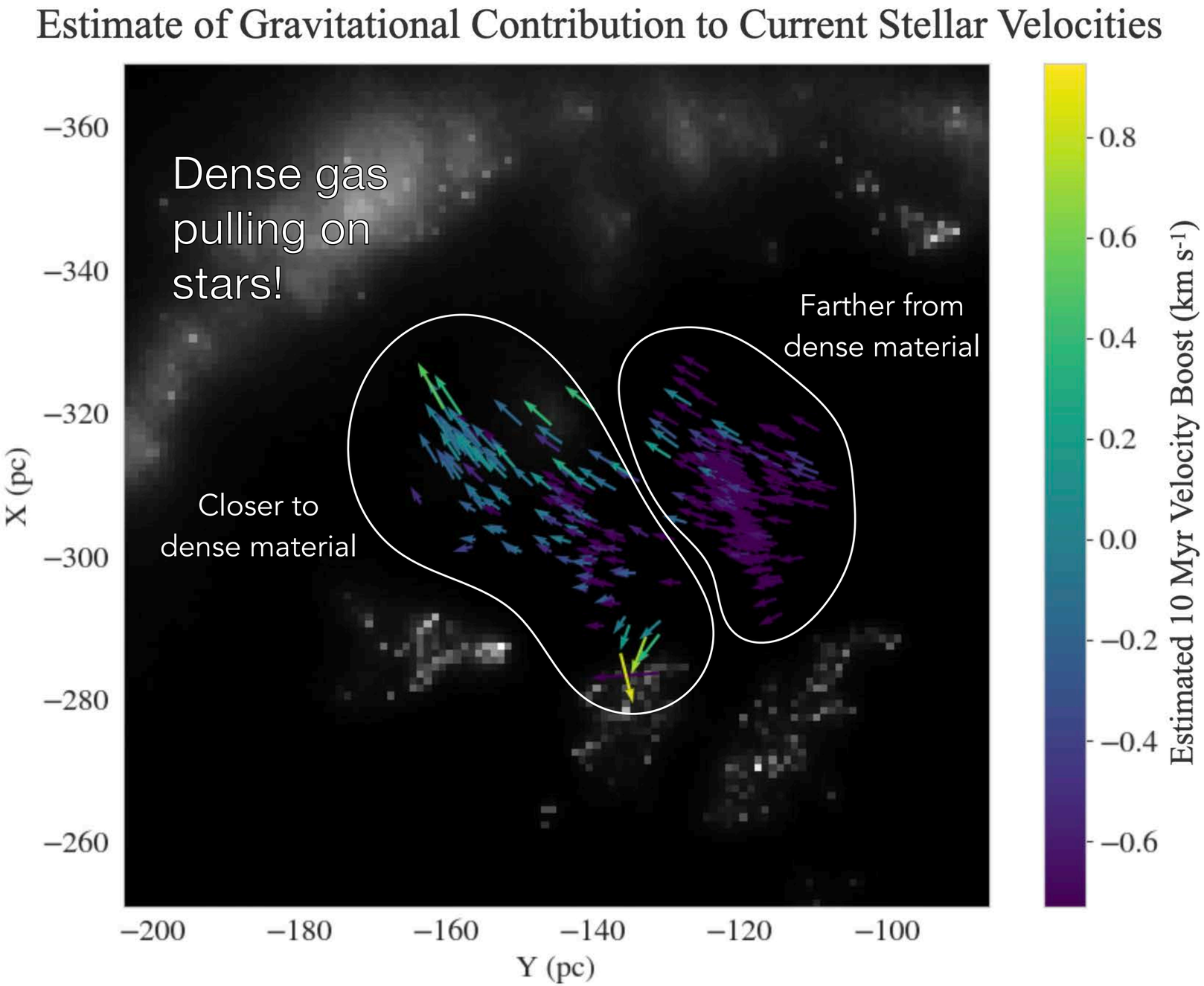


Where are supernovae?



What made Barnard's Loop?

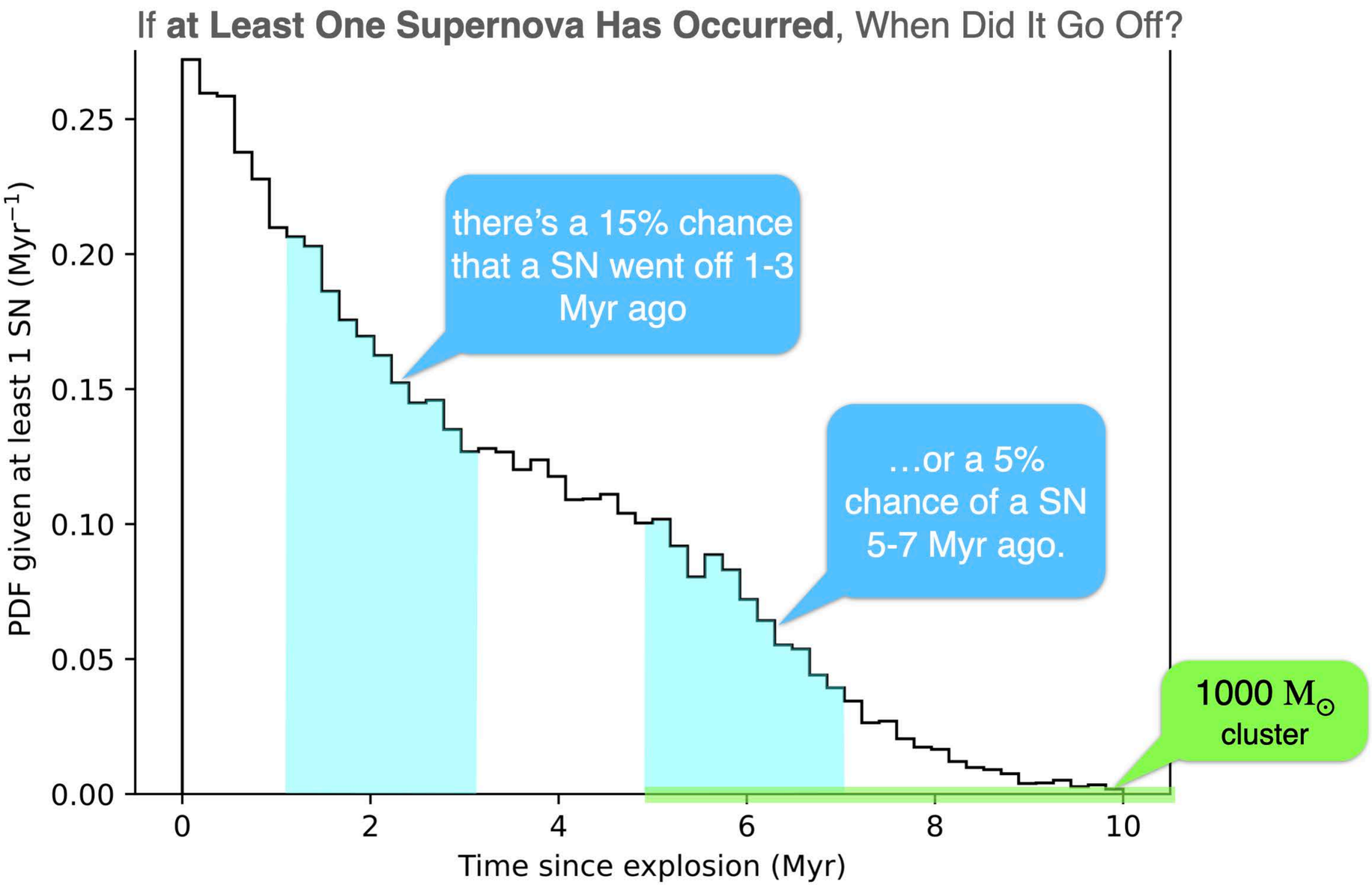




Stellar Motions

We can calculate how Anisotropic gravitational acceleration is reflected in motions of the stars

When Were Supernova Explosions?



Given the properties of any star cluster, we can estimate when supernovae would explode.

The cluster in Orion likely produced 1-2 supernovae within the last few million years.

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A 3D View of Orion: I. Barnard's Loop

INTERSTELLAR MEDIUM | ORION | STAR FORMATION | STELLAR FEEDBACK | SUPERNOVAE

+10 Michael Foley, Catherine Zucker, Alyssa Goodman, John C. Forbes, João Alves, Shmuel Bialy, cameren swiggum, Michael Y. Grudić, John Bally, Juan D. Soler, Josefa Großchedl, Torsten Ensslin, Reimar Leike

Abstract

Barnard's Loop is a famous arc of hydrogen-alpha emission located in the Orion star-forming region. Here, we provide evidence of a possible formation mechanism for Barnard's Loop and compare our results with recent work suggesting a major feedback event occurred in the region around 6 Myr ago. We expand on the discovery of a coherent, radial, 3D expansion of the OBP-Near/Briceño-1 (OBP-B1) cluster at the center of Barnard's Loop from Swiggum et al. 2021. This cluster appears to serve as another possible center for expansion of a number of young clusters identified in Grosschedl et al. 2021, which previously attributed the expansion center to Orion X. 3D dust mapping is used to characterize the 3D topology of the entire region, which shows Barnard's Loop's correspondence to a roughly spherical 3D cavity around the OPB-B1 cluster. Simple estimates of gravitational effects from both stars and gas indicate that gravitational feedback from the gas and dust may have strongly affected the kinematics of the stars in OBP-B1. We conclude that it is likely that at least one supernova occurred in the OBP-B1 cluster and played a major role in shaping the region.

Stay tuned for submission to ApJ June 2022

Check out the preprint!

https://tinyurl.com/orion3d

What can this tell us about star formation?

Stars may be “dragged” by dense material in expanding shells

All three molecular clouds appear to lie along the edge of the 3D dust shell

This strongly suggests that supernovae may be triggering star formation in Orion

Orion needed many supernovae to reach its current state

Supernovae from OBP-B1 likely played a major role in the formation of Barnard’s Loop